

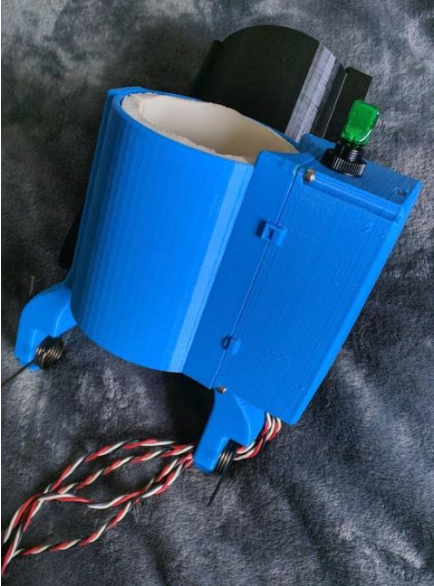

ACTION ITEMS

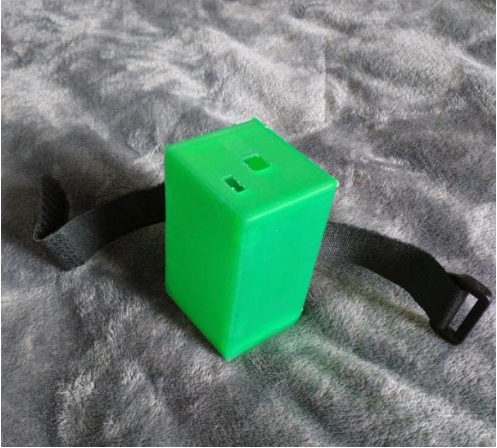
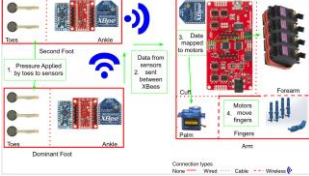
TEAM 12: Active Prosthetic Arm

Due Date:
Wednesday, May 1, 2019 5:30pm

The following are the Action Items from last week:

Team Member: Felicity Escarzaga

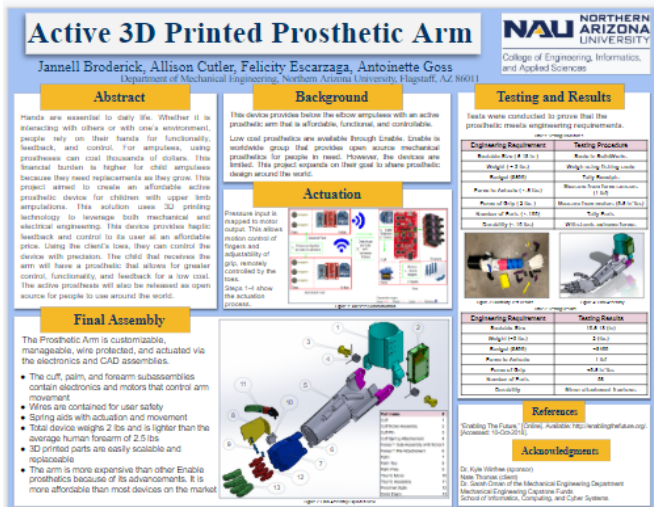
Action Item	Date Due	Date Completed	Result/Proof of Completion
1. Print final cuff	4/24	4/18	Cuff is printed in correct color with all changes completed and implemented. 
2. Print final ecase	4/24	4/22	Ecase has been printed in final color with all electronic components fitting inside and secure 

3. Print final fcase	4/24	4/22	<p>Foot case finished. Dimensions need revision for EE team's (Ethan Gage's) perfboard specs.</p>  <p>Final version sent to print.</p> <p>3D Print Request Confirmed</p> <p>Library Requested</p> <p>Thank you for confirming your 3D request. Your request for 3D prints can only be made based on research for the printer but will send you an email when your 3D items are ready to print.</p> <p>Thank you using the Open Library Materials</p> <p>Library: Open Library Staff Requested on: Open Library Staff 3D Request: Open Library Staff Library: Open Library Staff</p>
4. Check all code	4/24	4/23	<p>Pressure to motors complete, runs both vibration motors and actuation motor. Wireless communication implementation being perfected by EE team (Ethan Gage)</p>
5. Communicate with Client	4/24	4/22	<p>Invited Amanda and Nate to Ugrads presentation and poster via text.</p>
6. Help with poster	4/19	4/19	<p>Reorganized electronics flow chart for poster</p> 


Team Member: Antoinette Goss

Action Item	Date Due	Date Completed	Result/Proof of Completion
Print final palm and palm top	4/23/2019	incomplete	There appears to be a issue with the print. This was resolved by this afternoon but it will take a few more

			hours at least to print the final part
Make necessary adjustments to palm	4/24/2019	4/21/2019	<p>The designs were adjusted slightly for the motor hole and elevated finger placements. The palm top was designed for a slightly more secure attachment.</p>  

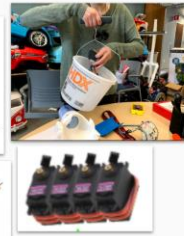
<p>Finalise poster for presentation</p>	<p>4/19/2019</p>		 <p>The poster is titled "Active 3D Printed Prosthetic Arm" and is from Northern Arizona University. It is authored by Jannell Broderick, Allison Cutler, Felicity Escarzaga, and Antoinette Goss. The poster is divided into several sections: Abstract, Background, Actuation, Final Assembly, Testing and Results, and Acknowledgments. It includes technical specifications, a list of components, and a photograph of the prosthetic arm.</p>
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<p>Print poster for presentation</p>	<p>4/23/2019</p>	<p>4/24/2019</p>	<p>Poster is ready for pick up. Re: UGRADS Poster Index</p> <p>Edwin Roy Anderson to *</p> <p>Hello,</p> <p>Your UGRADS poster is ready for pickup from the Physics Office (Bldg. 19, Rm. 209, x2861), which is open 8am-5pm M-F.</p> <p>NOTE: The ink on the poster will smear if it gets wet, including hand oil, so you don't want to flatten it out by running your hands over it when you put it up.</p> <p>-Ed</p> <p>----- Ed Anderson, MS Email: Ed_Anderson@nau.edu Support Systems Analyst, Pr. Phone: 520523-7056 Dept. of Physics and Astronomy FAX: 520523-1371 Northern Arizona University Cell: 520531-0892 500 Box 6010, Bldg. 19, Rm 209 527 S. Beaver St. Flagstaff, AZ, 86011-6010</p> <p>Home Page: http://www.physics.nau.edu/~anderson Staff Astronomer, NURO, http://www.nuro.nau.edu</p>
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<p>Finish Final Presentation</p>			<p>I have completed and/or edited th following slides for the presentation.</p>  <p>The slide is titled "Enable- Enabling the Future" and contains the following text:</p> <p>Motivation:</p> <ul style="list-style-type: none"> Groups such as enable provide affordable prosthetics for people in need. Kids Grow quickly and constantly need replacement arms to fit We wish to improve their design for electronic activation <p>The slide also features a photograph of a young girl using a prosthetic arm to hold a glass.</p>
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Testing Results

- Made 7 tests to determine if arm met requirements



Engineering Requirement	Testing Procedure
Scalable Size (6-18in)	Scale in SolidWorks
Weight (~3 lbs)	Weigh using fishing scale
Cost (\$500)	Tally Receipts
Force to Actuate (<5 lbf)	Measure from force sensors (1 lbf)
Force of Grip (2 lbf)	Measure from motors (9.5 in*lbs)
Number of Parts (<100)	Tally Parts
Durability (<10 lbs)	Withstands extreme forces

Goss 11

Testing Results



Engineering Requirement	Testing Results
Scalable Size	10.5-18 (in)
Weight (~3 lbs)	2 (lbs)
Cost (\$500)	~\$400
Force to Actuate	1 lbf
Force of Grip	+9.5 in*lbs
Number of Parts	98
Durability	Minor attachment fractures

Total Testing Results: Pass!

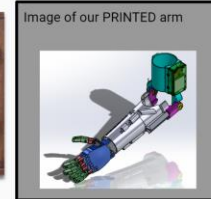
-minor adjustments to pins, but their durability is also expected to be lower. That is why they are easy to replace

Goss 12

Cost Comparison



Enable Arm
~\$30-\$40



Our Arm
~\$400.00



Michelangelo Arm
\$120,000

I will be presenting the testing result portion of the presentation.

Team Member: Jannell Broderick

Action Item	Date Due	Date Completed	Result/Proof of Completion
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Finalize UGRADS Poster 4/19/19 4/19/19

Active 3D Printed Prosthetic Arm
 Jannell Broderick, Allison Cutler, Felicity Escarzaga, Antoinette Goss
 Department of Mechanical Engineering, Northern Arizona University, Flagstaff, AZ 86011

Abstract
 Hands are essential to daily life. Whether it is interacting with others or with one's environment, people rely on their hands for functionality, feedback, and control. For amputees, using prosthetics can cost thousands of dollars. This financial burden is higher for child amputees because they need replacements as they grow. This project aimed to create an affordable active prosthetic device for children with upper limb amputations. This solution uses 3D printing technology to leverage both mechanical and electrical engineering. This device provides haptic feedback and control to its user at an affordable price. Using the child's toes, they can control the device with precision. The child that receives the arm will have a prosthetic that allows for greater control, functionality, and feedback for a low cost. The active prosthetic will also be released as an open source for people to use around the world.

Background
 This device provides below the elbow amputees with an active prosthetic arm that is affordable, functional, and customizable. Low cost prosthetics are available through Enable. Enable is a worldwide group that provides open source mechanical prosthetics for people in need. However, the devices are limited. This project expands on their goal to allow prosthetic design around the world.

Actuation
 Pressure input is required to motor output. This allows for a custom control of finger and adjustability of grip, velocity controlled by the toes. Stage 1-1 show the actuation process.

Final Assembly
 The Prosthetic Arm is customizable, manageable, wire protected, and actuated via the electronics and CAD assemblies.
 • The cuff, palm, and forearm subassemblies contain electronics and motors that control arm movement.
 • Wires are contained for user safety.
 • Spring aids with actuation and movement.
 • Total device weighs 2 lbs and is lighter than the average human forearm of 2.5 lbs.
 • 3D printed parts are easily scalable and replaceable.
 • The arm is more expensive than other Enable prosthetics because of its advancements. It is more affordable than most devices on the market.

Testing and Results
 Tests were conducted to prove that the prosthetic meets engineering requirements.

Engineering Requirement	Testing Procedure
Scalable (6-18in)	Adjustable CAD
Weight (2 lb)	Weight Testing Results
Budget (\$500)	Cost Analysis
Affordable for users	Material Properties (10 lbf)
Withstand wear and tare	Wear Testing Results
Actuation Force (<5 lbf)	Actuation Testing Results
Ease of Use	Actuation Testing Results
Grip Force (2 lbf)	Grip Testing Results
Number of Parts (<100)	Bill of Materials

References:
 • Enabling The Future / Create: Available for Download (Available for Download) (Accessed: 10-Oct-2019).
 • Dr. Julie Wilshire (Approach)
 • New Thread: enabler
 • Dr. Sarah Crowe of the Mechanical Engineering Department
 • Mechanical Engineering Capstone Course
 • School of Informatics, Computing, and Cyber Systems

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 Dr. Julie Wilshire (Approach)
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 School of Informatics, Computing, and Cyber Systems

After Allison and Felicity started the poster, Toni and I completed the poster. We organized the text, added figures and tables, and made all the poster concise.

Finalize UGRAD Presentation 4/24/19 4/21/19

Project Description

Objective:

- provide below-elbow amputees with an affordable prosthetic with haptic feedback.

Importance:

- it has the ability to make the wearer feel whole, have sense of belonging, feel unique, and enable their independence.

Enable- Enabling the Future

Motivation:

- Groups such as enable provide affordable prosthetics for people in need.
- Kids Grow quickly and constantly need replacement arms to fit
- We wish to improve their design for electronic activation

Customer Requirements:


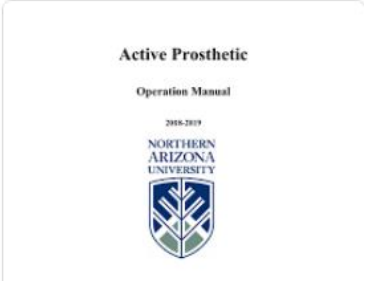
- Scalable
 - To fit individuals
- Lightweight
 - For comfort and liftability
- Haptic Sensing System
- Customization
- Aesthetical
- Easy to Clean
- Durable
- Reliable

Engineering Requirements:

- Scalable (6-18in)
 - Adjustable CAD
- Weight (2 lb)
- Budget (\$500)
 - Affordable for users
- Material Properties (10 lbf)
 - Withstand wear and tare
- Actuation Force (<5 lbf)
 - Ease of Use
- Grip Force (2 lbf)
- Number of Parts (<100)
 - Keep it simple

Exploded View of Arm Assembly

Part Name	ID
Cuff	1
Cuff Motor Assembly	2
Cuff Pin	3
Cuff Spring Attachment	4
Forearm Sub-Assembly with Motor 5	5
Forearm Pin Attachment	6
Palm	7
Palm Top	8
Palm Pin	9
Thumb Motor	10
Thumb Assembly	11
Proximal Digit	12
Distal Digit	13

			I completed the slides in the presentation. These slides introduce the project, the requirements, and the final cad design.
Assemble final prosthetic with team	4/24/19	Unfinished	This will be completed once all the parts are printed.
Print new fingers for final design	4/24/19	4/22/19	 <p>The final finger were printed and assembled. The fingers will be added to total assembly once all other parts are printed</p>
Complete user manual	4/26/19	Unfinished	 <p>The Operation/user manual has been started. This Manual will help users assemble and use the prosthetic device. Once completed, the manual will explain how each subassembly will fit together. It will include the mechanical components.</p>

Team Member: Allison Cutler

Action Item	Date Due	Date Completed	Result/Proof of Completion
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1. Finalize UGRADS Poster

4/19/19

4/19/19

Active 3D Printed Prosthetic Arm
 Jannell Broderick, Allison Cutler, Felicity Escarzaga, Antoinette Goss
 Department of Mechanical Engineering, Northern Arizona University, Flagstaff, AZ, 86011

Abstract
 Hands are essential to daily life. Whether it is interacting with others or with one's environment, people rely on their hands for functionality, feedback, and control. For amputees, using prostheses can cost thousands of dollars. This financial burden is higher for child amputees because they need replacements as they grow. This project aimed to create an affordable active prosthetic device for children with upper limb amputations. This solution uses 3D printing technology to leverage both mechanical and electrical engineering. This device provides haptic feedback and control to its user at an affordable price. Using the child's toes, they can control the device with precision. The child that receives the arm will have a prosthesis that allows for precise control, functionality, and feedback for a low cost. The active prostheses will also be released as open source for people to use around the world.

Background
 This device provides better elbow amputees with an active prosthetic arm that is affordable, functional, and controllable. Low cost prostheses are available through Enable. Enable is worldwide group that provides open source mechanical prostheses for people in need. However, the devices are limited. This project expands on their goal to share prosthetic design around the world.

Actuation
 Pressure input is required to create output. This allows precise control of fingers and adaptability of grip, velocity controlled by the user. Steps 1-4 show the actuation process.

Final Assembly
 The Prosthetic Arm is customizable, manageable, wire protected, and actuated via the electronics and CAD assemblies.
 • The cuff, palm, and forearm subassemblies contain electronics and motors that control arm movement
 • Wires are contained for user safety
 • Spring axils with actuation and movement
 • Total device weighs 2 lbs and is lighter than the average human forearm of 2.5 lbs
 • 3D printed parts are easily scalable and replaceable
 • The arm is more expensive than other Enable prosthetics because of its advancements. It is more affordable than most devices on the market.

Testing and Results
 Tests were conducted to prove that the prosthetic meets engineering requirements.

Engineering Requirement	Testing Procedure
Weight (1.2 lbs)	Weighting Testing scale
Range of Motion	Flexion/Extension
Force of Motion (2 lbs)	Maximum Force exertion (1.5 lbs)
Number of Parts (1-10)	Minimum Components (2.5 lbs)
Flexibility (10 lbs)	Flexion/Extension Force

References
 Scaling the Future. (2016, October 15). Available from: www.3dprinting.com [Accessed 10-Oct-2016].

Acknowledgments
 Dr. Kyle Wilshire (sponsor)
 Kyle Wilshire (design)
 Dr. Scott Olson of the Mechanical Engineering Department
 Mechanical Engineering Capstone Course
 School of Information, Computing, and Cyber Systems

- Visuals were updated, tables were updated, logo was changed, and figure/table numbers given
- Sentences restructured to be bullet points
- Abstract updated and resubmitted

2. Finalize UGRAD Presentation

4/24/19

4/21/19

- Worked with team and made the changes mentioned in class on 4/17.
- Edited the testing results, project description, conclusion, and budget
- Here is an example of budget modification: now includes comparison with other prosthetics

14 Final Product Cost



Item	Quantity	Unit Cost	Total Cost
3D Printed Parts	1	\$150.00	\$150.00
Electronics	1	\$80.00	\$80.00
Assembly	1	\$50.00	\$50.00
Shipping	1	\$20.00	\$20.00
Materials	1	\$10.00	\$10.00
Tools	1	\$10.00	\$10.00
Testing	1	\$10.00	\$10.00
Documentation	1	\$10.00	\$10.00
Marketing	1	\$10.00	\$10.00
Travel	1	\$10.00	\$10.00
Contingency	1	\$10.00	\$10.00
Total			\$360.00

15 Cost Comparison

Prosthesis	Weight	Price
Enable	2.5 lbs	\$1,500
Open Source	2 lbs	\$500
Commercial	2 lbs	\$2,000

16 Conclusion

- Successful design team, available to growing and available
- Project suitable for future use and price
- Can hold same with finger
- Has haptic/feedback in vibrating motors

3. Print final forearm	4/24/19	Ongoing	 <ul style="list-style-type: none"> The Makers Lab had technical errors when confirming the back half of the forearm print, and the print was not started on 4/19 like an email said. After talking to the Maker's Lab, the print was started on 4/24 and will be complete 4/25. If more complications occur, an old prototype will be painted and used for UGRADS The Makers Lab incorrectly printed the front half of the forearm, so this will have to be reprinted before giving the arm to our Client. However, it is good enough for UGRADS
4. Assemble final prosthetic with team	4/24/19	Unfinished	<ul style="list-style-type: none"> Do to the printing complications on multiple subsystems of the arm, assembly has not yet occurred. The team will have an assembled arm before UGRADS
5. Test electrical assembly with forearm	Unassigned	4/22/19	 <ul style="list-style-type: none"> The wire holes and tubing successfully lead the wires to the cuff Motors fit inside the forearm with the lid on

The following are the Action Items for next week:

Team Member	Action Items	Date Due
Felicity	<ol style="list-style-type: none"> Complete user manual Finalize Presentation slides Assemble prosthetic with team Present at Ugrads Complete final report 	<ol style="list-style-type: none"> 4/26 4/26 4/25 4/26 5/1

Antoinette	<ol style="list-style-type: none"> 1. Present at Ugrads 2. Complete final report 3. Complete user manual 4. Assemble prosthetic with team 	<ol style="list-style-type: none"> 1. 4/26/2019 2. 5/1/2019 3. 4/26/2019 4. 4/25/2019
Jannell	<ol style="list-style-type: none"> 1. Finish User's Manual 2. Ugrad's Presentation 3. Website Update 4. Final Report 	<ol style="list-style-type: none"> 1. 4/26/2019 2. 5/01/2019 3. 5/01/2019 4. 5/01/2019
Allison	<ol style="list-style-type: none"> 1. Assemble prosthetic with team 2. Finalize images in Oral Presentation 3. Present at UGRADS 4. Add images and finalize Operation Manual sections about Forearm and Maintenance 5. Begin correct reprint of forearm for Client 6. Start Honors Capstone requirements 	<ol style="list-style-type: none"> 1. 4/25/2019 2. 4/26/2019 3. 4/26/2019 4. 4/26/2019 5. 5/1/2019 6. 5/1/2019